

Presses for Oil and Wine in the Southern Levant in the Byzantine Period

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A remarkable variety of agricultural installations were in use concurrently and alongside one another in the southern Levant during the Byzantine period (324–640 C.E.). In order to explain this phenomenon, an attempt will be made here to define the character of the technical cultures that existed in the southern Levant, show how these cultures developed, and how they were related to technical cultures of other areas. It is necessary, therefore, to broaden the terms of reference to include earlier periods (in order to explain the origin of the various devices) and other regions (in order to show what is specific to the southern Levant). The data on which this paper is based are a catalogue of hundreds of installations that are drawn mainly from the archives of the Archaeological Survey of Israel and from those of the Mandatory Department of Antiquities of Palestine.¹

STAGES OF PRODUCTION

In the production of both wine and oil in the southern Levant, there were three main stages. In wine production, the grapes were first trodden in a treading installation or winery, which consisted of a treading floor and a collecting vat to which the must flowed. This is the Hebrew **תַּחַת** and the Greek **ληνός**, usually misleadingly translated as a “wine-press.”² These installations were typically cut in bedrock and very simple.³ They are

¹The catalogue of installations in Israel and its environs is in R. Frankel, “The History of the Processing of Wine and Oil in Galilee in the Period of the Bible, the Mishna and the Talmud” (Ph.D. diss., Tel Aviv University, 1984, in Hebrew). An expanded catalogue including other Mediterranean countries will appear in R. Frankel, *Wine and Oil Production in Antiquity in Israel and Other Mediterranean Countries*, forthcoming.

²In biblical Hebrew this installation is referred to as **תַּחַת** or **בָּקִי** and once apparently as **תַּרְבֵּעַ**. The **תַּחַת** is primarily the treading floor, and the **בָּקִי** primarily the collecting vat. In the Vulgate both of these terms are always translated as “torcular,” while in the Septuagint they are usually both translated as **ληνός**; in one case (Isa. 5:2), however, **בָּקִי** is translated as **προλήνιον**, “in front of the winery,” and in several others as **ὑπολήνιον**, “below the winery.” The translation of these terms as “torcular,” “winepress,” and “pressoir” has led to the representation of the “pressoir mystique” in medieval Christian iconography in the form of a true press—lever press or screw press. See *Le pressoir mystique*, ed. D. Alexandre-Bidon and J. Delumeau (Paris, 1990). This misunderstanding is due in part to the fact that the simple rock-cut winery is extremely rare in Europe, probably because in Europe it often rains during the vintage season, whereas south of the Mediterranean rain almost never falls during the summer months.

³E.g., G. W. Ahlström, “Wine Presses and Cup-Marks of the Jenin-Megiddo Survey,” *BASOR* 231 (1978), 19–49; A. Raban, *Archaeological Survey of Israel: Nahalat Map (28) 16–23* (Jerusalem, 1982), 53, 54, 64, 68, 69.

found in large numbers in the countryside outside settlement sites, indicating that they were generally located in the actual vineyards.⁴ Although most cannot be dated, there are fine examples from as early as the Bronze Age,⁵ and they continued unchanged until modern times. Some are still being used to make grape syrup in the Hebron area. There is, however, also a great variety of more complex wineries. These usually have an intermediate settling or sieving vat, a true press normally in the center of the treading floor, and various ancillary treading floors and compartments around the main floor to pre-treat the grapes and to contain the various substances that were added to the must. The most sophisticated of these are from the Byzantine period.⁶

The second stage in wine production, an optional part of the process, was to press out the must remaining in the grape skins after treading, using a true press. The third stage was the fermentation. In the Levant the first fermentation usually took place in the vat of the winery, the capacity of which was often very great, reaching as much as 10 cubic meters.

In oil production, the olives were first crushed, and from the Hellenistic period onward nearly always in a rotary olive crusher.⁷ A round crushing stone was fitted on a shaft that served also as a handle and revolved on a central pivot. The stone was turned by hand or by an animal, and it rotated both on its own axis and around the basin. In the second stage, the olive mash was put into baskets or frails,⁸ which were piled one upon the other, and pressed. The third stage was the separation of the oil from the black watery lees. Here I will discuss the true presses that were used in the second stages of both wine and oil production.

The simplest press, Type A, is the lever (or beam) and weights press. For this press, a beam is anchored at the fulcrum while its free end moves up and down. To the free end are attached weights—which are attached by ropes—that lower the beam, which then exerts pressure on the frails of olive mash or grape skins (Fig. 1a). A second press, Type B, which is described by Cato the Elder,⁹ is a lever and drum press, in which a drum attached to the ground replaces the weights of Type A. The lower end of a rope was wound around the drum; turning the drum with the aid of handspakes lowered the beam and exerted pressure (Fig. 1b). A third press, Type C, is the lever and screw press, in which a screw replaces the rope of the previous types. Turning the screw (or in some

⁴Cf. Isa. 5:1–2, Matt. 21:33, and Mark 12:1.

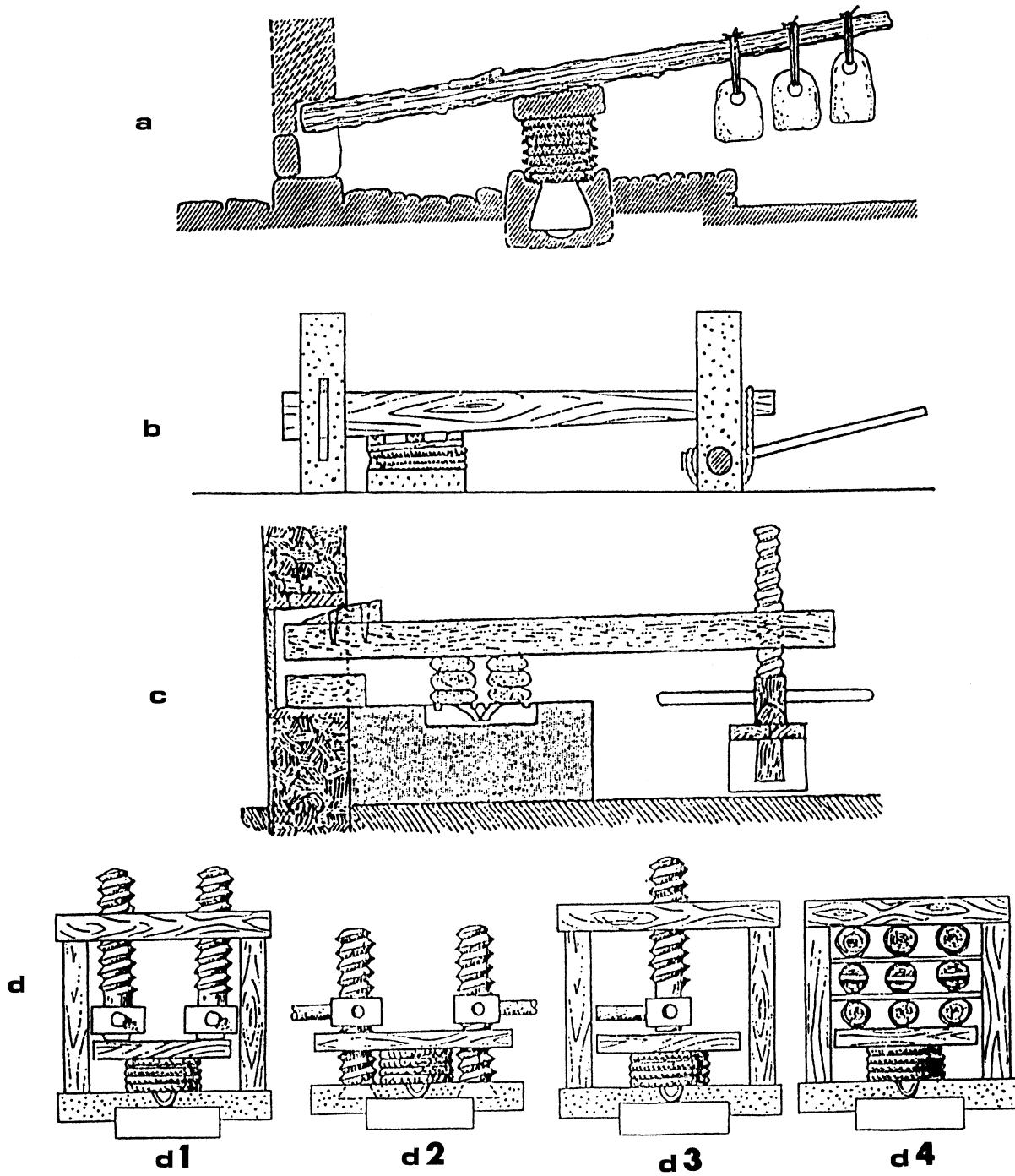
⁵Those from Megiddo stratum XX cannot be later than Chalcolithic (G. Loud, *Megiddo II* [Chicago, 1948], fig. 132, 4 and 5), and those from Tel Ta'annek (Taanach) not later than the Middle Bronze Age (P. W. Lapp, "The 1968 Excavations at Ta'annek," *BASOR* 195 [1969], 2–49, esp. 12, fig. 8).

⁶E.g., G. Mazor, "The Wine-Presses of the Negev," *Qadmoniot* 14.53–54 (1981), 51–60 (in Hebrew); I. Roll and E. Ayalon, "Two Large Wine Presses in the Red Soil Regions of Israel," *PEQ* 130 (1981), 111–25; S. Saller and E. Testa, *The Archaeological Setting of the Shrine of Bethphage* (Jerusalem, 1961), 27–41.

⁷R. Frankel, "The Trapetum and the Mola Olearia," in *Oil and Wine Production in the Mediterranean Area*, ed. M.-C. Amouretti and J.-P. Brun, *BCH suppl.* 26 (Athens, 1993), 477–81; R. Frankel, S. Avitsur, and E. Ayalon, *History and Technology of Olive Oil in the Holy Land* (Arlington, Va.–Tel Aviv, 1994), 30–33, 105, 107–11.

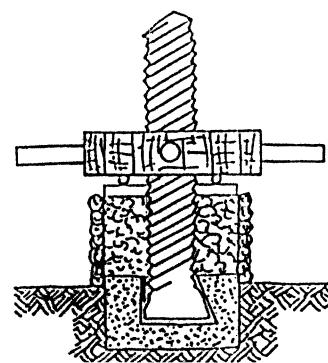
⁸Mishnaic Hebrew: *לְפָנָים*; Latin: *fiscus, fiscina, fiscella*. R. D. White, *Farm Equipment of the Roman World* (Cambridge, 1975), 88–91.

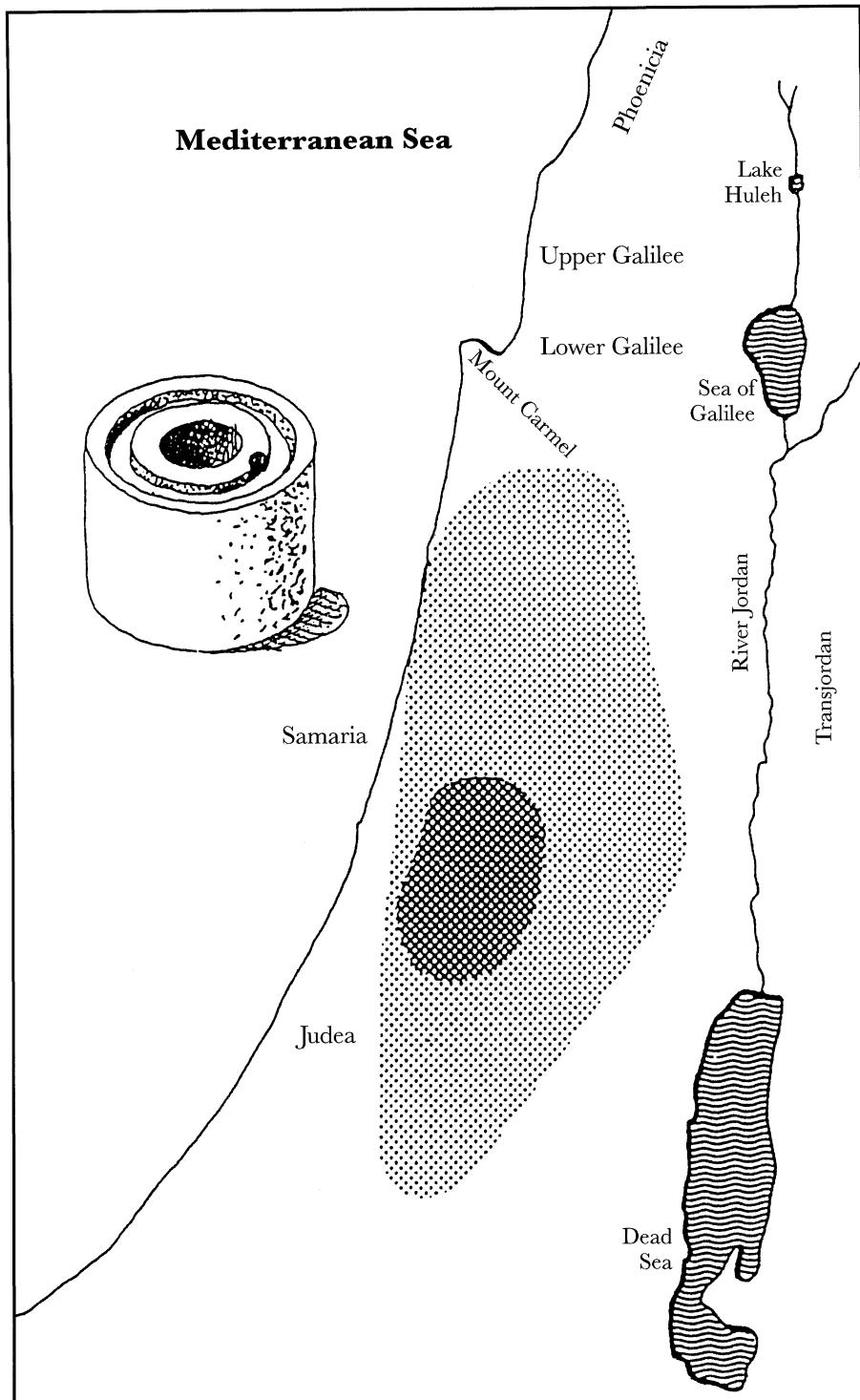
⁹Marcus Porcius Cato, "De Agri Cultura," in Cato and Varro, *De Re Rustica*, trans. W. D. Hooper and H. B. Ash (Cambridge, Mass.–London, 1979), chap. 18; A. G. Drachman, *Ancient Oil Mills and Presses* (Copenhagen, 1932), 99–121; J.-P. Brun, *L'oléiculture antique en Provence* (Paris, 1986), 236–47.



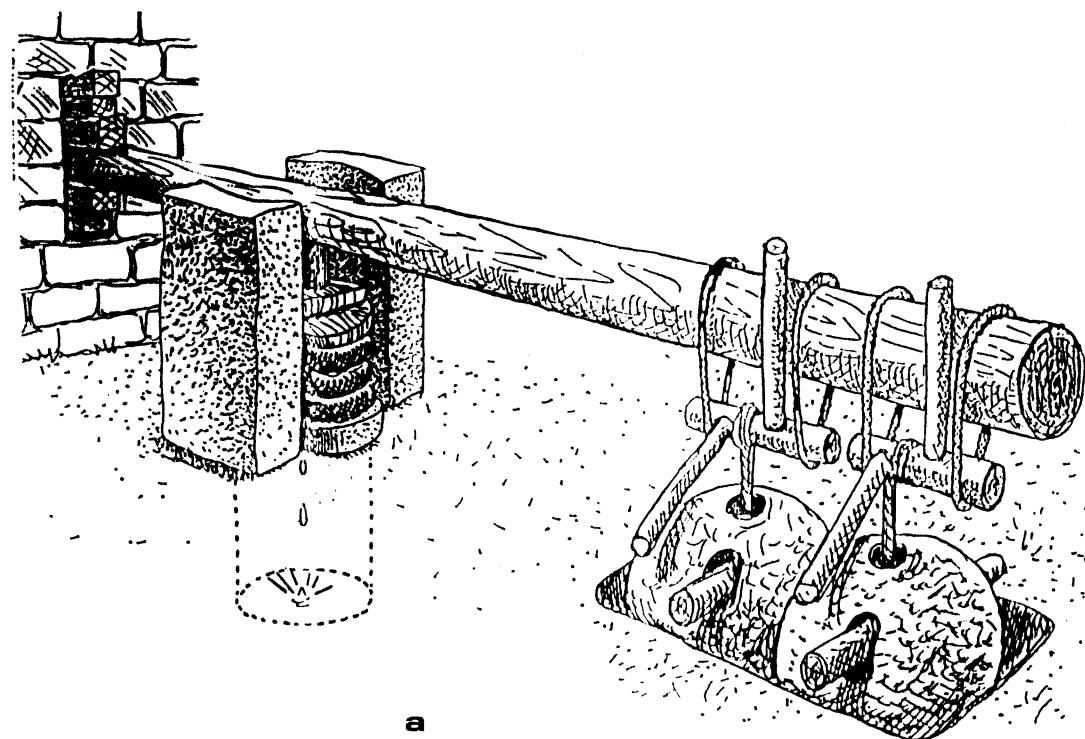
- 1 The main types of presses
 - a. Lever and weights press
 - b. Lever and drum press
 - c. Lever and screw press
 - d. Rigid-frame direct pressure presses:
 - d1. Double rotary screw press
 - d2. Double fixed screw press
 - d3. Single rotary screw press
 - d4. Wedge press
 - e. Single fixed screw press

(drawings: a, b, d, and e after Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, 39, 49, 64, 75; c after Paton and Myres, "Karian Oil-Presses," 210)

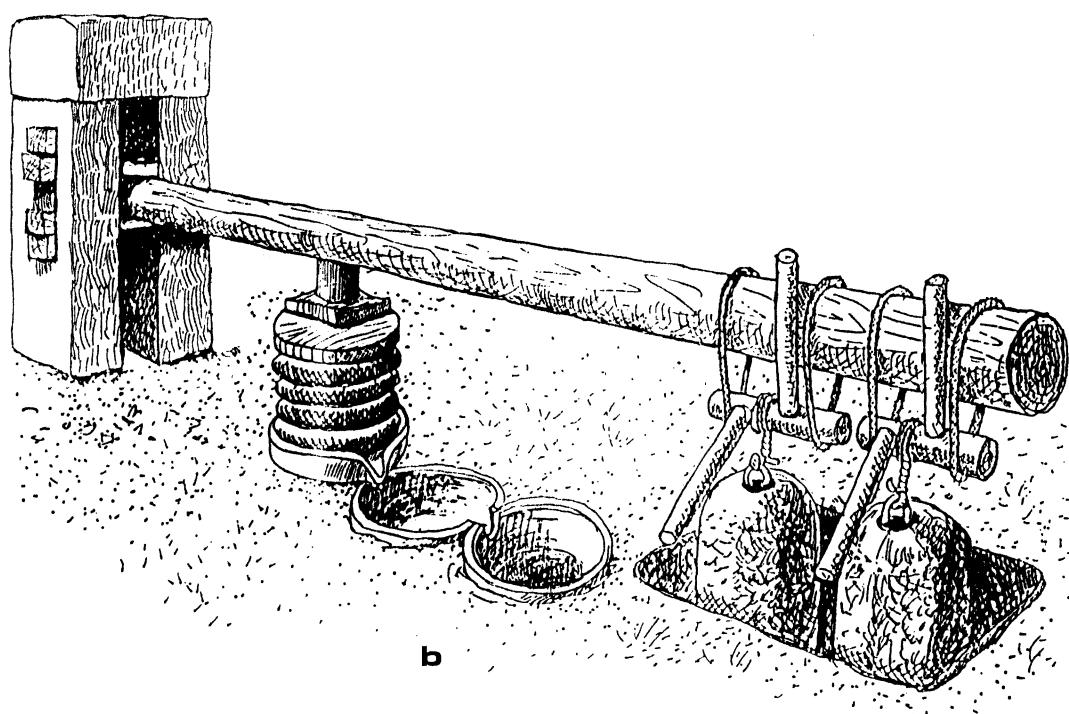




2 Distribution of the Iron Age freestanding central collecting vat
(drawing: after Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, 38)

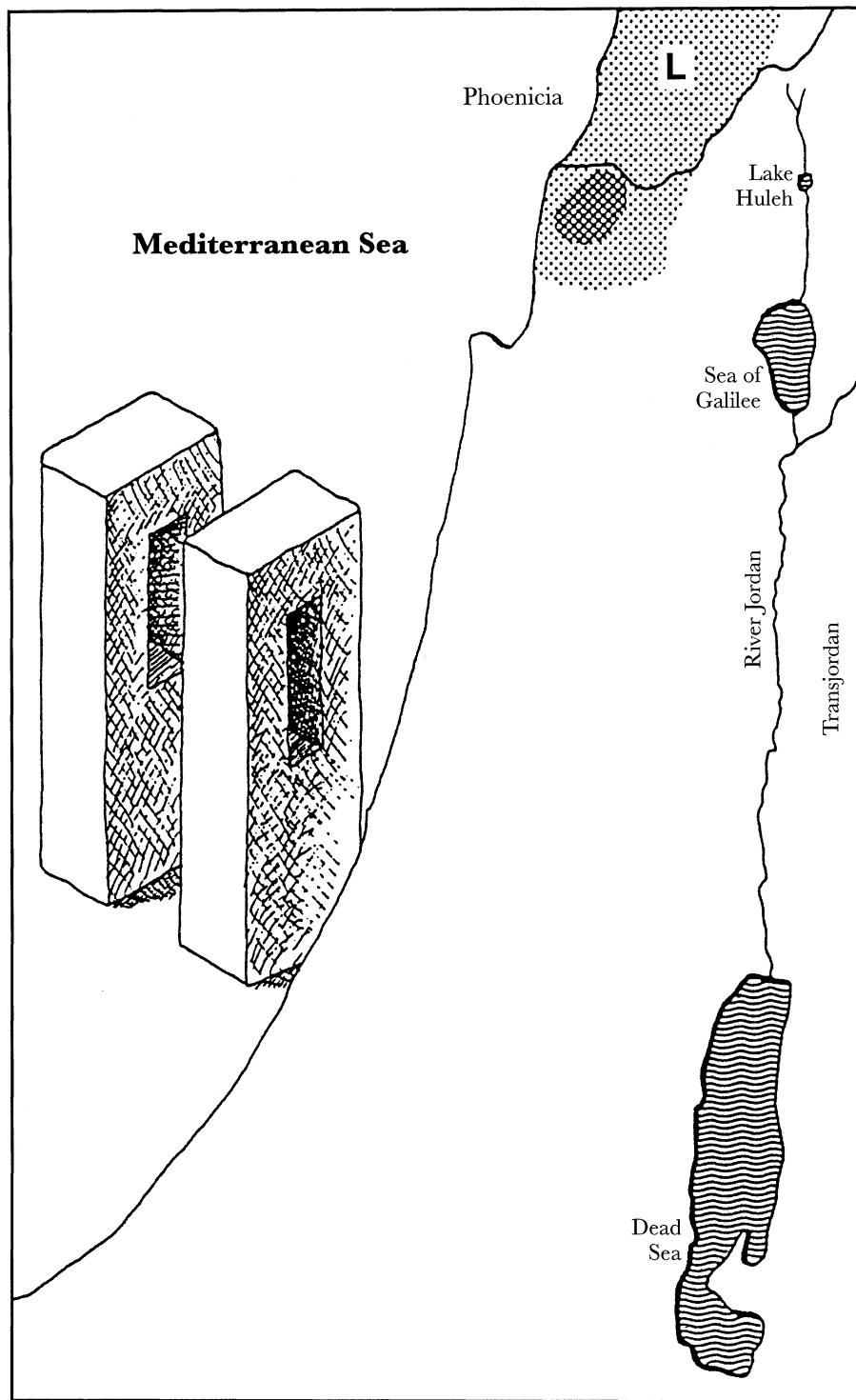


a

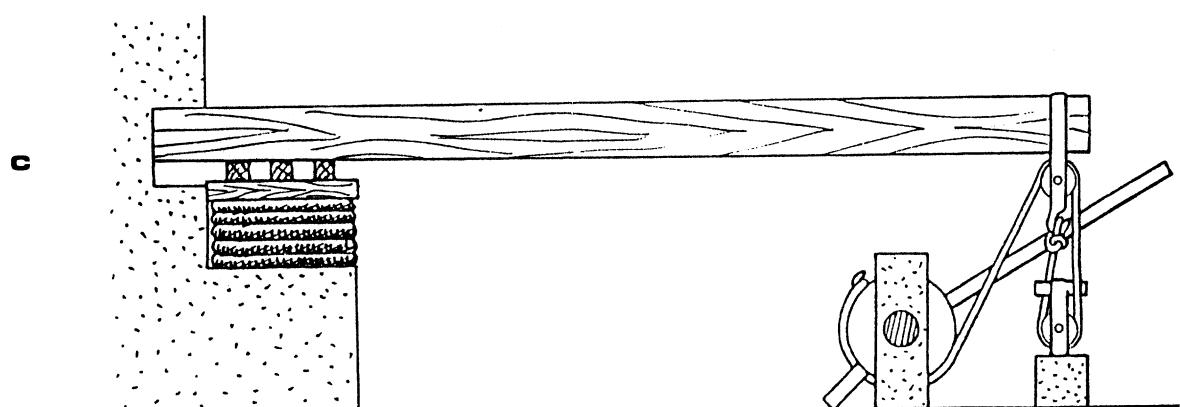
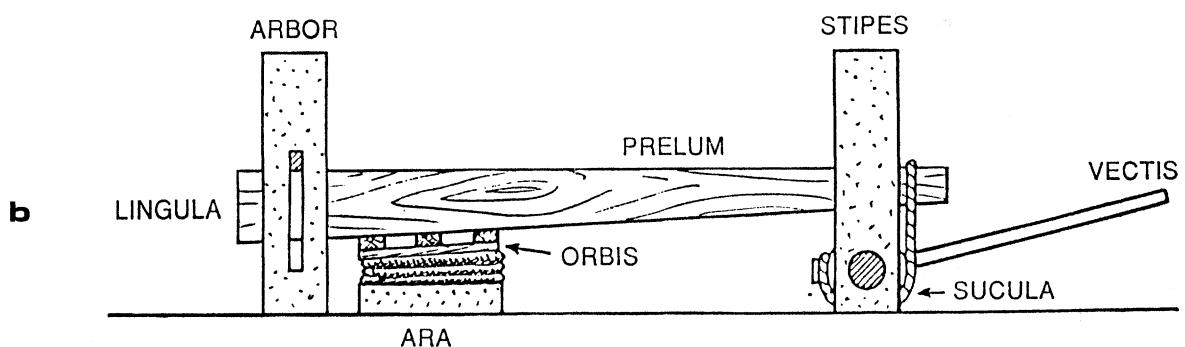
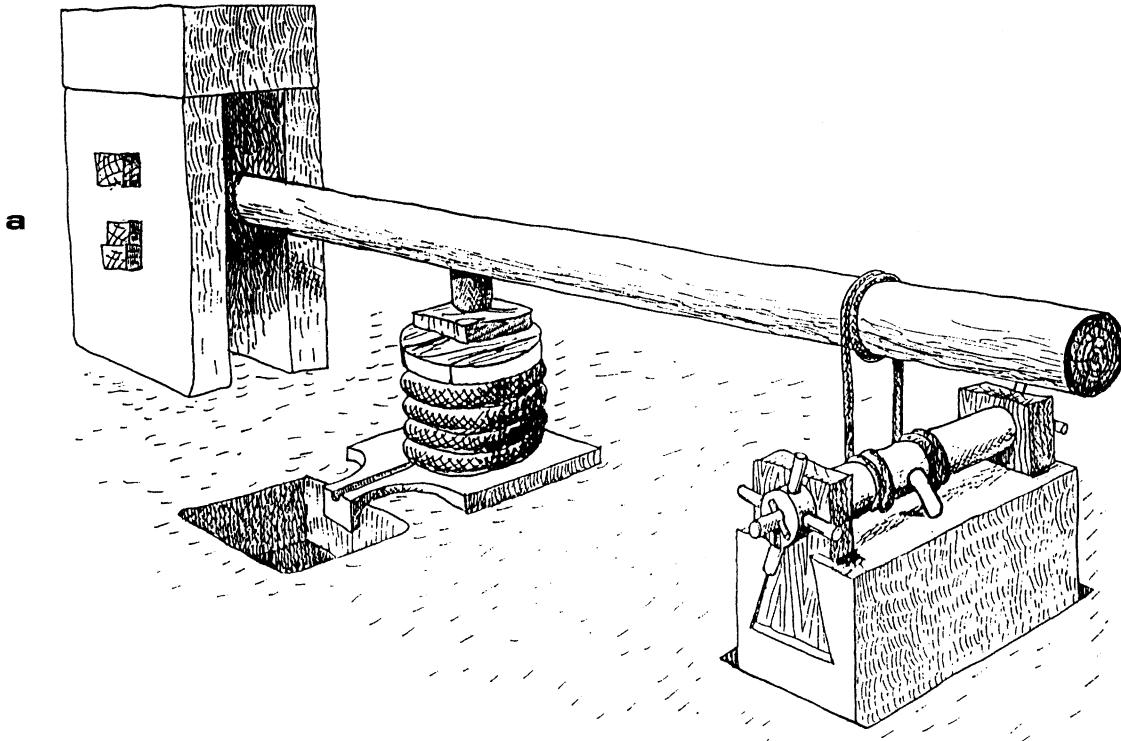


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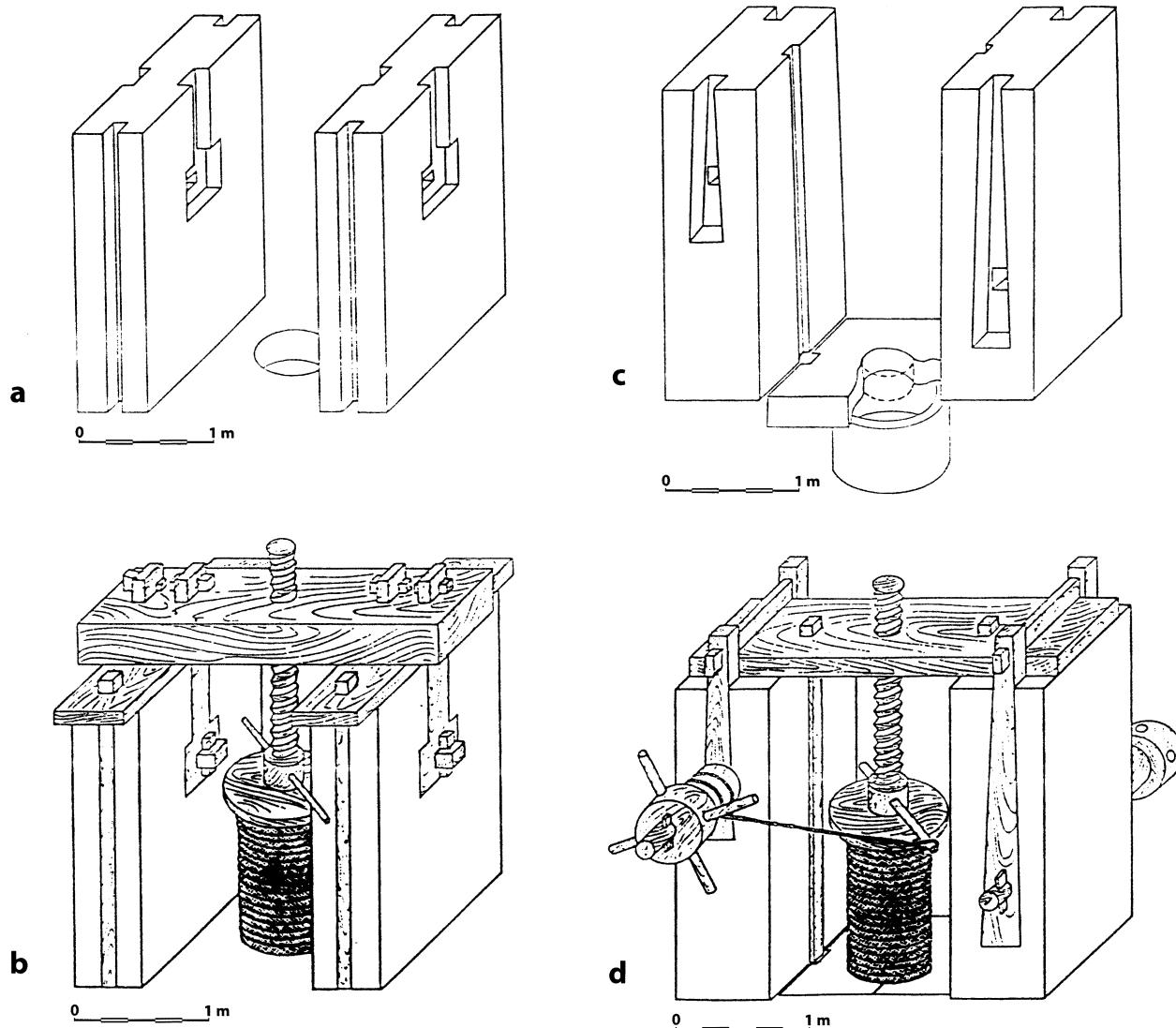
3 a. Southern improved lever and weights press, or the Maresha press
b. Northern improved lever and weights press, or the Zabadi press
(drawings: after Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, 41, 44)



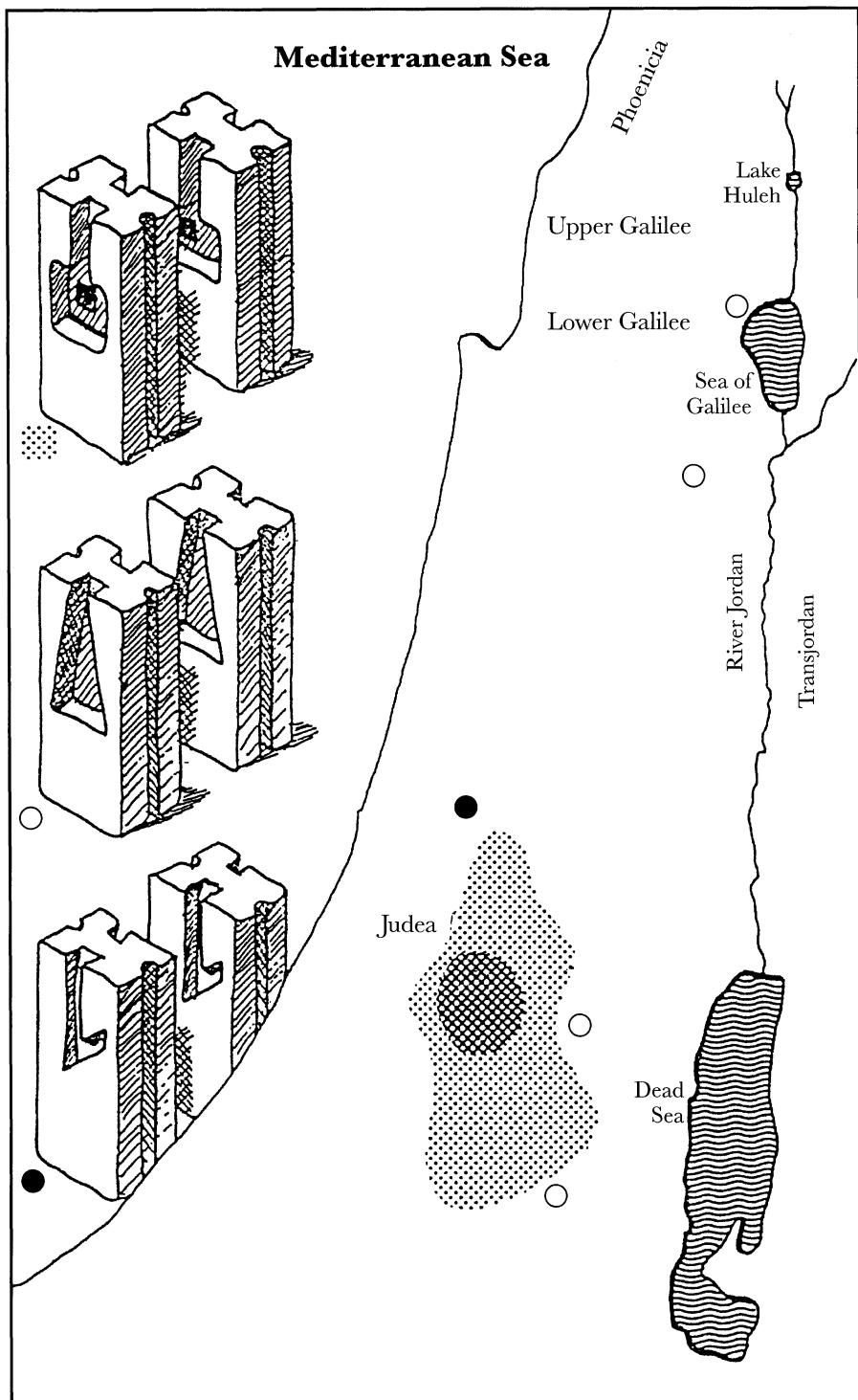
4 Distribution of slotted piers. L designates the region in Lebanon where the distribution is presumed. (drawing: after Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, 44)



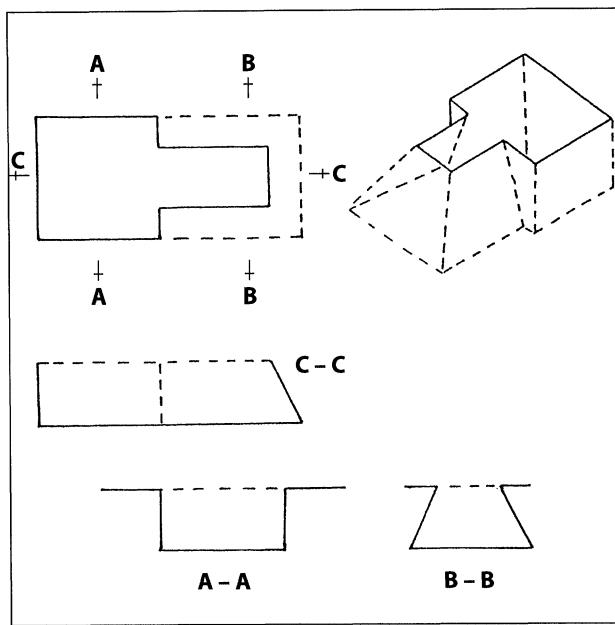
5 a. Reconstruction of a Tripolitanian lever and weights press with perforated piers and Semana weight
 b. Cato's lever and drum press
 c. Hero of Alexandria's lever, weight, and drum press
 (drawings: after Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, 47, 49, 50)



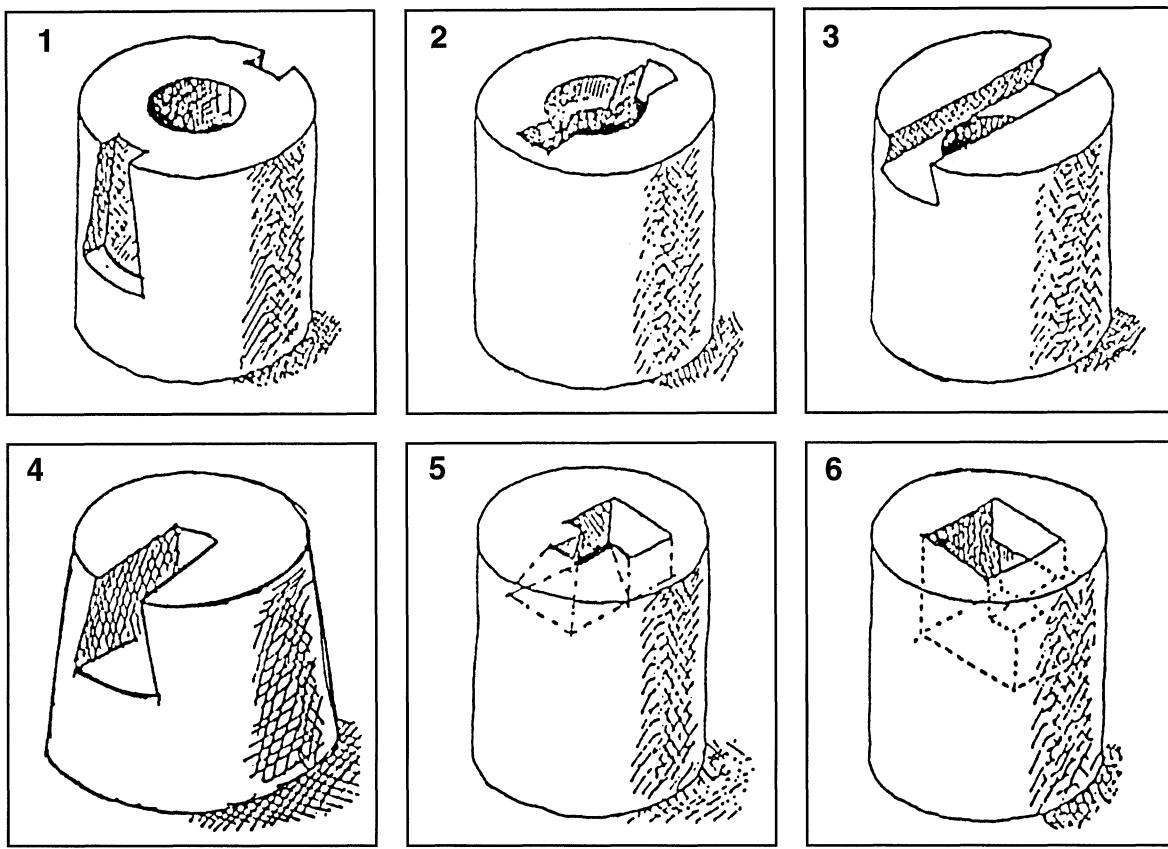
6 Judean grooved pier press: (a) as found in excavations and (b) reconstructed
 Sufafot grooved pier press: (c) as found in excavations and (d) reconstructed
 (drawings: after Frankel, “Sufafot,” 84–85)



7 Distribution of the main type (*top*) and variants of the Judean grooved pier press
(drawing: after Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, 69)



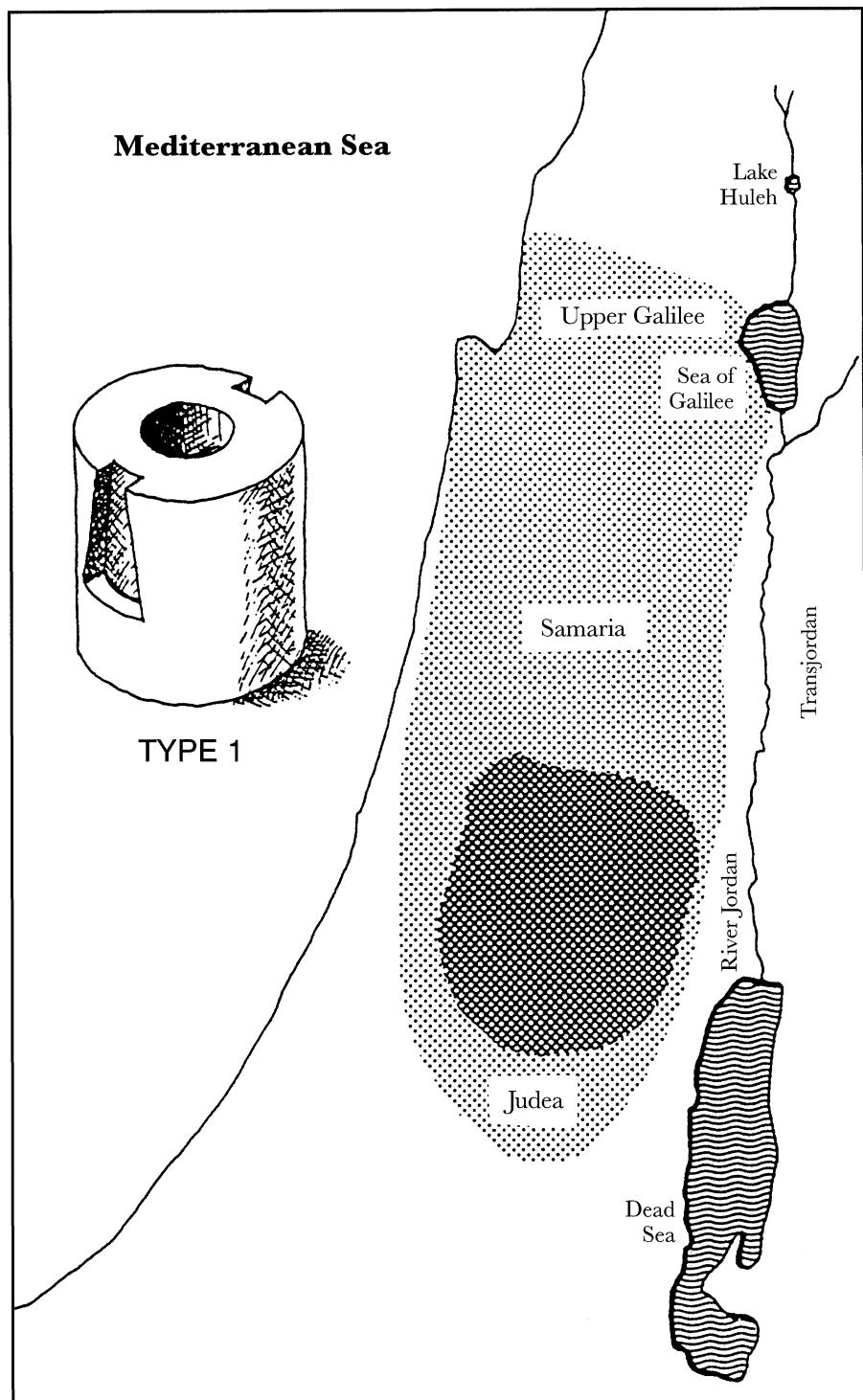
8 Central dovetail mortice, the Phoenician type
(drawing: Hagit Tahan)



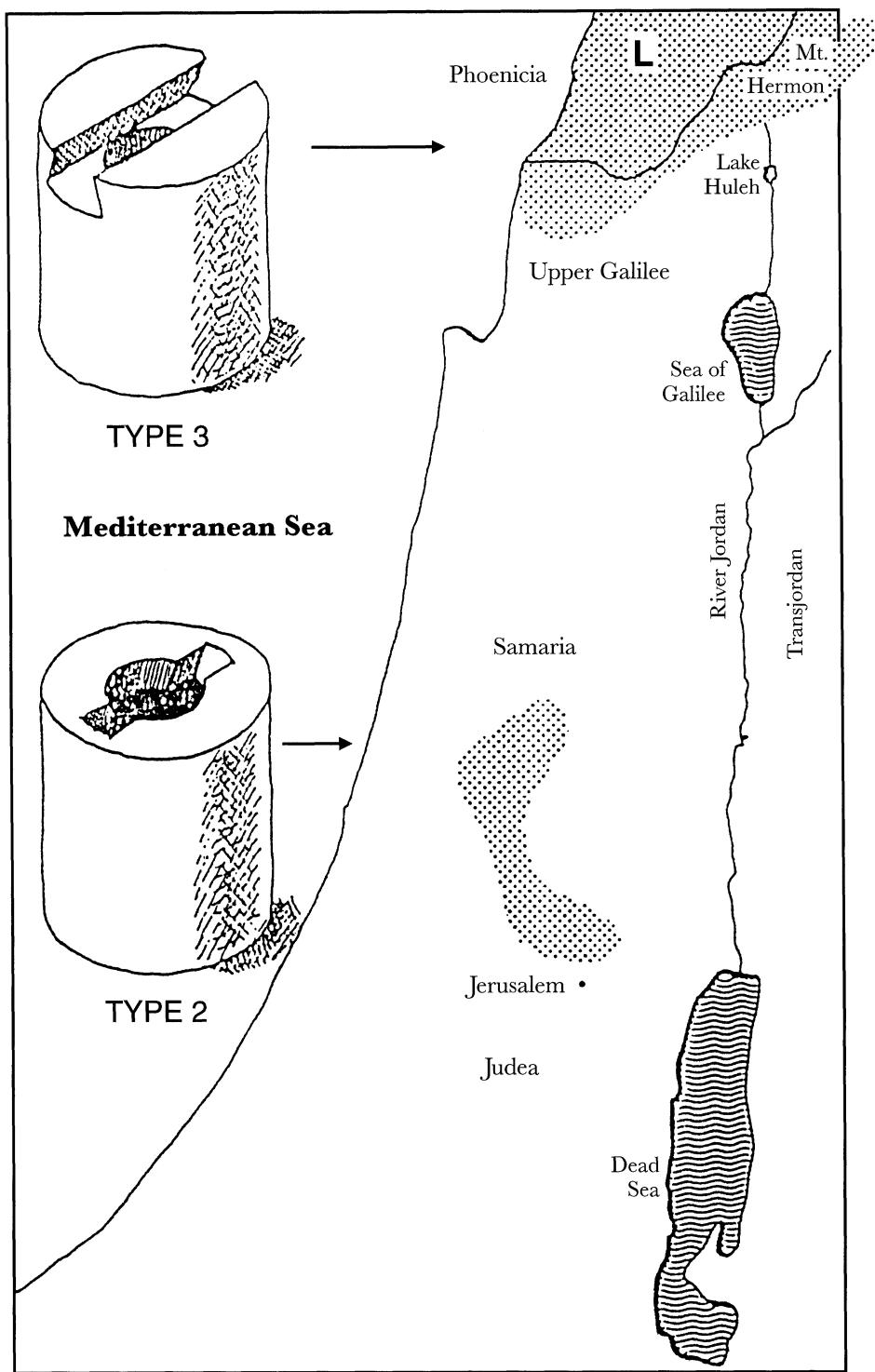
9 Six main types of screw weights

1. Samaria weight
2. Kasfa weight
3. Din'ila weight
4. Mi'ilia weight
5. Bet Ha'emeq weight
6. Luvim weight

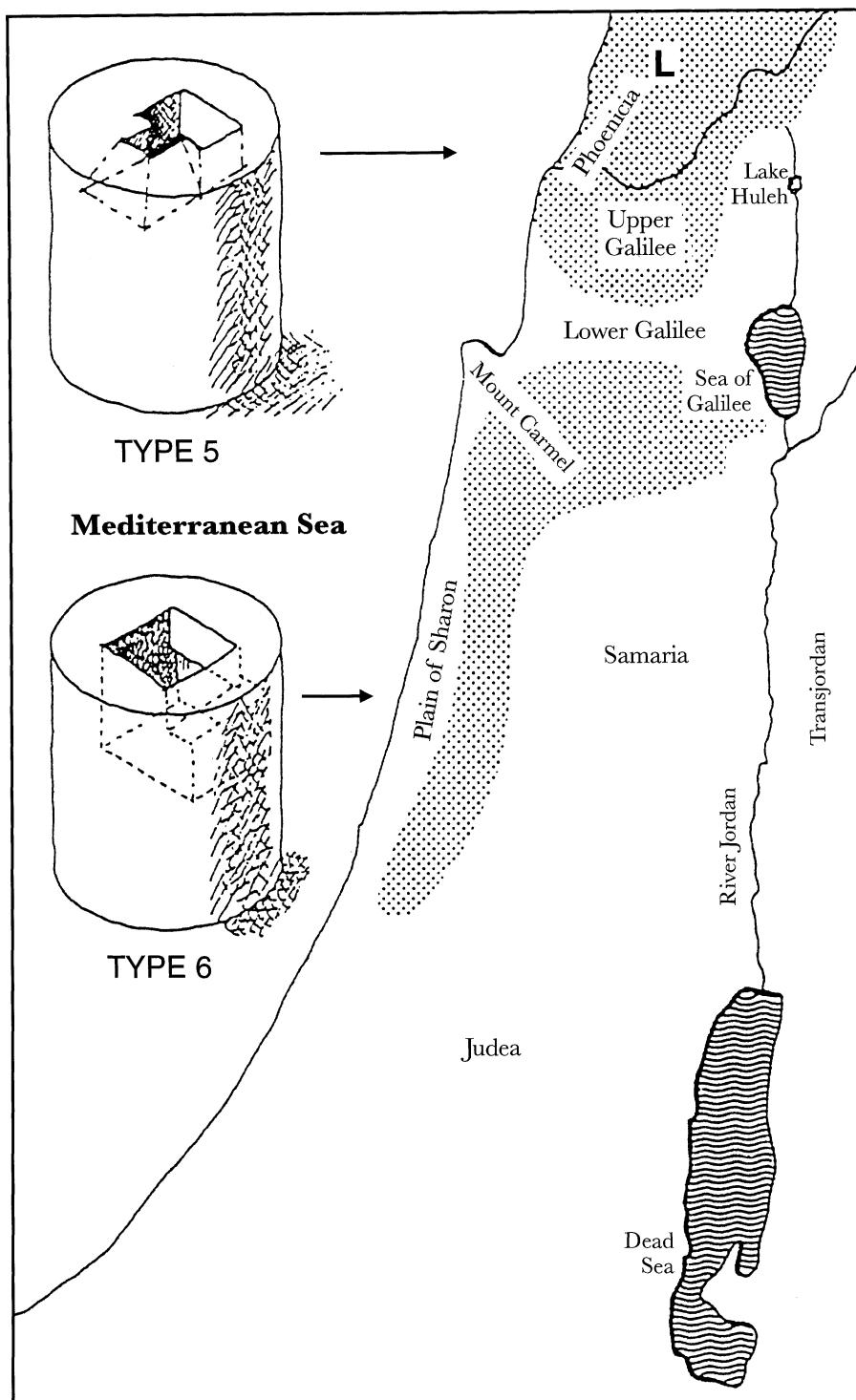
(drawings: after Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, 61)



10 Distribution of the (I) Samaria weight
(drawing: after Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, 53)

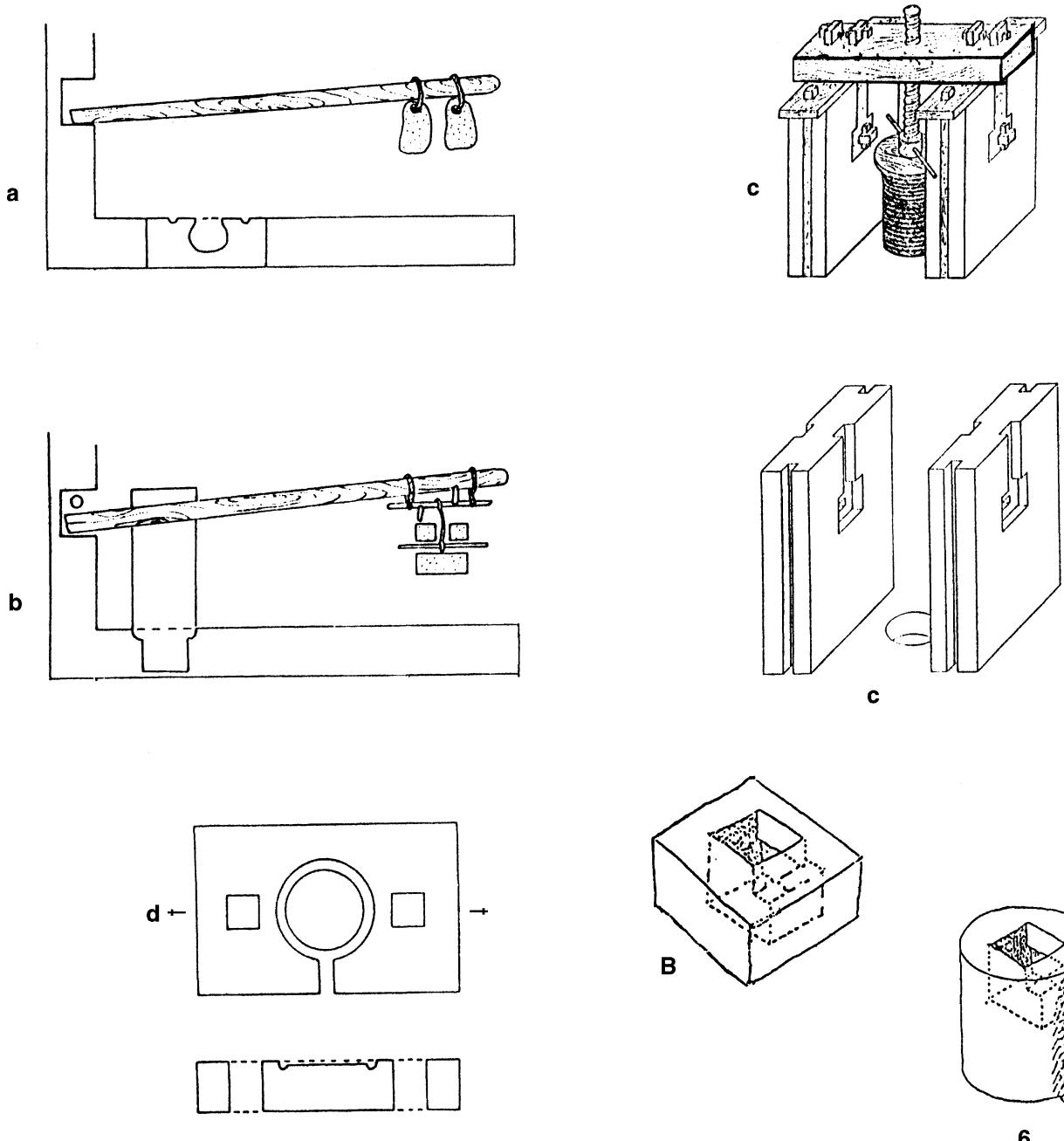


11 Distribution of the (2) Kasfa weight and the (3) Din'ila weight. *L* designates the region in Lebanon where the distribution is presumed.
 (drawing: after Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, 54)



12 Distribution of the (5) Bet Ha'emeq weight and the (6) Luvim weight.
L designates the region in Lebanon where the distribution is presumed.
 (drawing: after Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, 59)

South



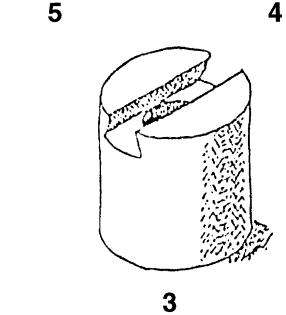
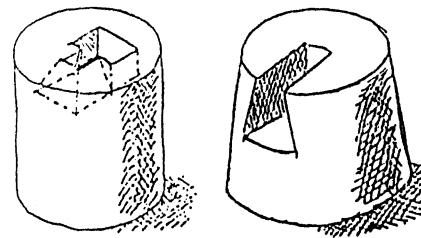
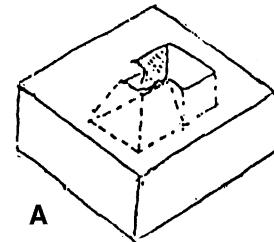
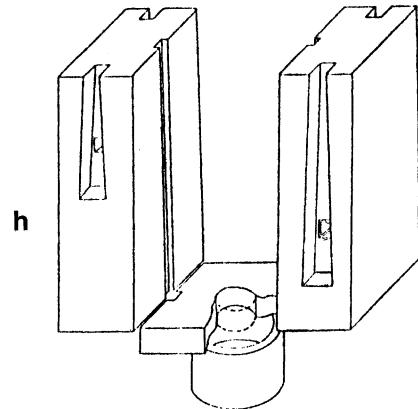
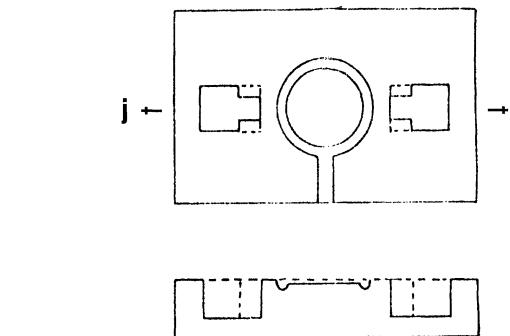
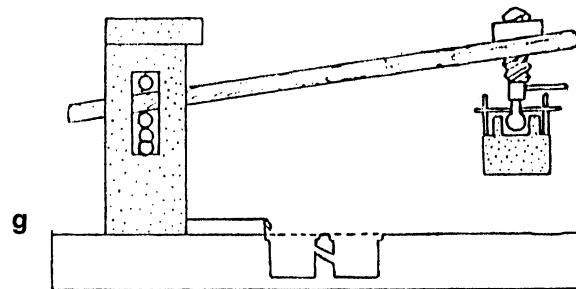
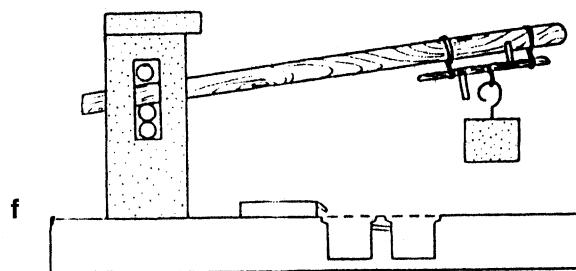
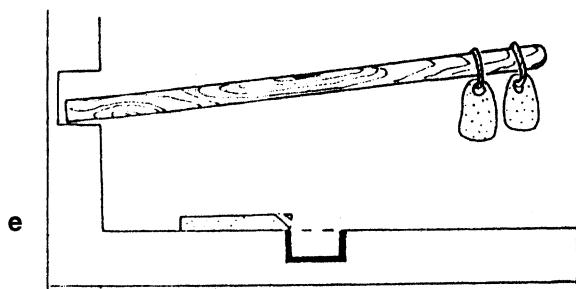
13 Comparison of southern and northern (*opposite*) technical cultures

South

- Iron Age Beit Mirsim press
- Hellenistic Maresha lever and weights press
- Judean grooved pier press
- Screw press base with square mortices
- Ayalon winepress mortice
- Luvim screw weight

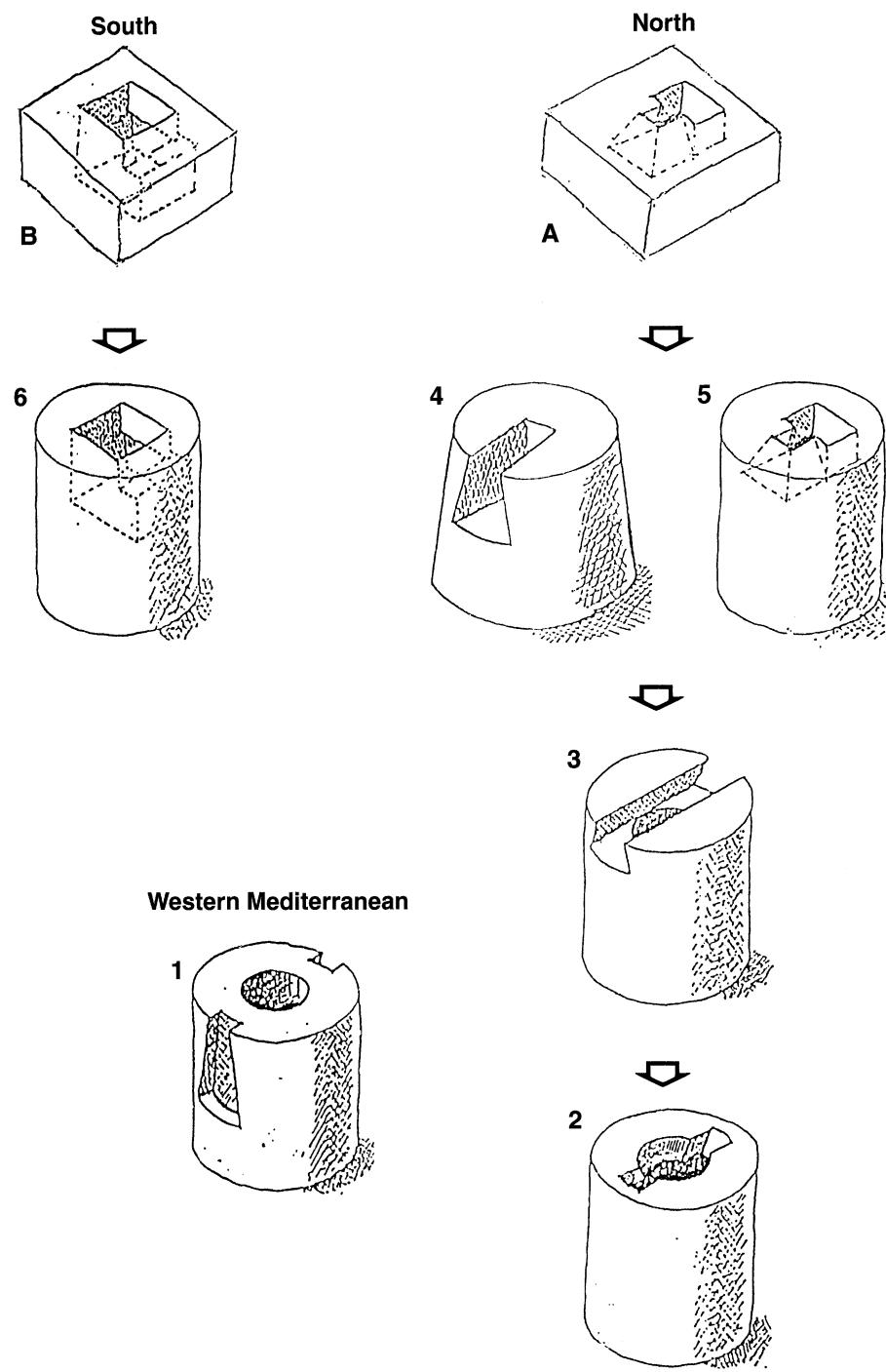
(drawings: a, b, d, e, f, g, j, A, and B by Hagit Tahan; 3, 4, 5, and 6 after Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, 61; and c and h after Frankel, “Şafşafot,” 84–85)

North



North

- e. Iron Age Rosh Zayit lever and weights press
- f. Roman Zabadi lever and weights press
- g. Lever and screw press
- h. Ṣafṣafot grooved pier press
- j. Rama screw press base
- A. Ḥanita winepress mortice
- 3. Din‘ila screw weight
- 4. Mi‘ilia screw weight
- 5. Bet Ha‘emeq screw weight



14 Suggested development of winepress mortices and screw weights
South

- B. Ayalon winepress mortice
- 6. Luvim screw press

North

- A. Hanita winepress mortice
- 4. Mi'ilia screw weight
- 5. Bet Ha'emeq screw weight
- 3. Din'ila screw weight
- 2. Kasfa screw weight

From the Western Mediterranean

- 1. Samaria screw weight

(drawings: weights after Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, 61;
mortices by Hagit Tahan)

types the nut that is above the beam) lowers the beam and gradually raises the weight into the air (Fig. 1c). There are also lever and screw presses without weights, in which the lower end of the screw is held in the press frame or between two posts attached to the ground. A fourth press, Type D, is the rigid-frame direct pressure press, which includes various double rotary screw presses, double fixed screw presses, the single rotary screw press, and wedge presses (Fig. 1d). These types have been grouped together because, although they are technically very different from each other, the stone parts of these types of presses—which in archaeological contexts are usually all that remains—can in most cases not be distinguished. A fifth press, Type E, is the single fixed screw press, in which the rotating nut exerts pressure directly (Fig. 1e). This type of press was used only for wine and is found apparently only in the southern Levant.

It must be stressed that although these five types of presses do, to some extent, represent a sequence of technical progress,¹⁰ one does not find every stage in every region, and with the introduction of a new technique the old methods were not always abandoned. As a result, for example, at the beginning of this century different types of pre-industrial presses were operating side by side still using nearly all the methods practiced in the southern Levant in ancient times. The study of these pre-industrial presses aids in understanding how to reconstruct the devices found in archaeological sites, because in the latter the working parts made of wood and other perishable materials have rarely survived. Also of great importance is the fact that the pre-industrial presses of a region usually reflect the techniques used in that region in ancient times.

HISTORY AND DEVELOPMENT

The first important technical advance in the development of the press was the introduction of the use of the lever. At several sites in Cyprus and at Ugarit in Syria, there is evidence for lever and weights presses in the Late Bronze Age, but in Israel the earliest examples known at present are from the Iron Age.¹¹ At this period a regional differentiation between north and south can already be distinguished, which continues into later times. In the northern type, the Rosh Zayit press, the oil collection is lateral: the crushed olives are pressed on a press bed, and the expressed liquid flows into a lateral vat placed to the side of the bed (see Fig. 13e).¹² This was the usual method throughout the ancient

¹⁰Pliny the Elder gives a survey of the history of the press in *Naturalis Historia*, trans. H. Rackman (Cambridge, Mass.-London, 1949–63), 18.74.317. If Jüngst and Thielscher's revision of the text is accepted, Pliny presents three types of presses in chronological order: a lever and drum press, in the time of "our forefathers"; a lever and screw press, "within the last hundred years"; and a direct pressure single rotary screw press, "within the last 22 years." There is no reason not to accept Pliny's description as true for Roman Italy, but it is not necessarily true for other regions. See E. Jüngst and P. Thielscher, "Catos Keltern und Kollergänge," *BJ* 157 (1957), 53–126, esp. 108–9.

¹¹Cyprus: S. Hadjisavvas, *Olive Oil Processing in Cyprus* (Nicosia, 1992), 21–25; Ugarit: O. Callot, "Les huilleries du Bronze Récent à Ugarit, premiers éléments pour une étude," in M. Yon, *Le centre de la ville Ras Shamra-Ugarit III, 38e–44e campagnes (1978–1984)* (Lyons-Paris, 1987), 197–212; Israel: The earliest lever and weights press is from Iron Age I from Dan. See A. Biran, "Two Discoveries at Tel Dan," *IEJ* 30 (1980), 89–98, esp. 91–95; O. Borowski, "A Note on the 'Iron Age Cult Installation' at Tel Dan," *IEJ* 32 (1982), 58; L. E. Stager and S. R. Wolff, "Production and Commerce in Temple Courtyards: An Olive Press in the Sacred Precinct at Tel Dan," *BASOR* 243 (1981), 95–102.

¹²Z. Gal and R. Frankel, "An Olive Press Complex at Ḥurbat Rōš Zayit (Rās ez-Zētūn) in Lower Galilee," *ZDPV* 109 (1993), 36–41.

world. However, in the southern type, the Beit Mirsim press, the method used is that of central collection. W. F. Albright describes the installations he found at Tel Beit Mirsim as dyeing vats, but G. Dalman suggests that they are oil presses, an interpretation shown to be correct by D. Eitam.¹³ The crushed olives are pressed directly on the vat, so the two components—press bed and vat—were combined into one central vat (Fig. 13a). The Iron Age beam weights are simple, having only one perforation—in the south fashioned, in the north consisting of unworked fieldstones. The distribution map of the central vat in the Iron Age is clearly defined. It is found almost only south of Mount Carmel (Fig. 2).

In the Hellenistic and Roman periods, two main types of regional lever and weights presses can again be distinguished. Each clearly developed from the type found previously in their respective regions. In the southern type, the Maresha press, the beam is anchored in a niche, and the collection is, again, central (Fig. 3a).¹⁴ The main innovation is that two plain piers stand on either side of the central vat. Their purpose is to support the olive mash frails and the beam when it is raised and not in use. In the northern type, the Zabadi press, the collection is, again, lateral, as in the Rosh Zayit press. Here there are two main innovations. First, instead of a niche at the fulcrum, there are two slotted piers. Crosspieces placed in the slots secured the beam. Second, instead of one collecting vat, there are usually two, allowing the floating oil to flow into the second vat and thus be separated (Fig. 3b).¹⁵ The northern Zabadi press, although also a lever and weights press, is different from the southern Maresha press in almost every respect.

The distribution map of the slotted piers is, again, clearly defined, it being limited to the northwestern areas of the southern Levant, that is, Phoenicia (Fig. 4). The slotted piers are the *arbores* of the press described by Cato¹⁶ and the מִלְחָמָה of the Mishnaic oil press;¹⁷ this device is also very common in pre-industrial presses in western Europe.¹⁸ At Umm al-'Amed in Lebanon, slotted niches were found, one of them associated with a Hellenistic oil press.¹⁹ These probably represent the prototype of the slotted piers, as they are at present the earliest dated example of the use of slots of this type to anchor the beam end of a press. This strongly suggests that slotted piers originated in the Levant.

Three types of beam weights were found in the southern Levant in late antiquity, and all three are still attested in twentieth-century pre-industrial installations: a weight with a metal ring,²⁰ a simple weight with a horizontal bore,²¹ and the typical weight of

¹³ W. F. Albright, *The Excavation of Tell Beit Mirsim*, III, AASOR 21–22 (1941–43), 55–62; G. Dalman, *Arbeit und Sitte in Palästina* (Gutersloh, 1928–42; repr. Hildesheim, 1964–), V, 77–78; D. Eitam, “Olive Presses of the Israelite Period,” *Tel Aviv* 6 (1979), 146–55.

¹⁴ A. Kloner and N. Sagiv, “The Olive Presses of Hellenistic Maresha, Israel,” in Amouretti and Brun, *Oil and Wine Production* (as above, note 7), 119–35.

¹⁵ R. Frankel, “Some Oil Presses from Western Galilee,” *BASOR* 286 (1992), 39–71.

¹⁶ See above, note 9.

¹⁷ Mishnah, *Baba Batra* 4:5; Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, 79–80.

¹⁸ E.g., X. Humbel, *Vieux pressoirs sans frontières* (Paris, 1976), fig. 22, pls. VI, VIII, XVI, XVIII, XX, XXI.

¹⁹ M. Dunand and R. Duru, *Oumm el-'Amed* (Paris, 1962), fig. 19b, 138–39 (no. E153).

²⁰ E.g., Zabadi (Roman): Frankel, “Presses from Western Galilee,” 40–46; Kfar Hay-Lebanon (pre-industrial): R. Cresswell, “Un pressoir à olives au Liban: essai de technologie comparée,” *L'Homme: Revue française d'anthropologie* 5 (1965), 33–63.

²¹ E.g., Umm al-'Amed (Hellenistic): Dunand and Duru, *Oumm el-'Amed*, fig. 18; 'Aglun ('Ajlun) (pre-industrial): Dalman, *Arbeit*, IV, fig. 55.

the region, that with a reversed T-shaped bore.²² A rope is inserted through the vertical bore and is tied to a rod in the horizontal bore. The weight with the reversed T-bore has been found also in Lebanon and Cyprus, dating from the Hellenistic period onward. Pre-industrial evidence shows that all three of these weights were raised using a drum attached to the beam.²³ This, however, was not the only method of raising weights. In the western Mediterranean—southern France, North Africa, and Spain—a completely different type of weight is found—the Semana weight, rectangular with dovetail mortices on its short sides and a groove on the top.²⁴ In this type of weight, which probably originated in the Aegean,²⁵ the drum is attached to the weight (Fig. 5a).²⁶ In Cato's press, described also by Pliny²⁷ and typical of Roman Italy, there is no weight, and the drum is held between two short piers fixed to the ground, Cato's *stipites* (Fig. 5b). Note that the *arbores* of Cato's press are identical to the slotted piers of the Phoenician Zabadi press (Fig. 3b).²⁸ It is of interest that Hero of Alexandria, in his lever, weight, and drum press,²⁹ combines the weight of the Levantine press with the drum of Cato's press (Fig. 5c).

The lever presses of the different regions of the Mediterranean area vary not only in that some are operated by a weight while others are not, and in the use of differing weights, but also in other attributes, primarily the manner in which the lever is anchored at the fulcrum. I have already discussed the main methods used in the southern Levant:

²² Maresha (Hellenistic): Kloner and Sagiv, "Maresha," figs. 1, 8, 9, 10; al-Tafila (pre-industrial): Dalman, *Arbeit*, IV, fig. 56.

²³ Dalman, *Arbeit*, IV, figs. 55, 56; Cresswell, "Pressoir à olives"; Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, fig. 116.

²⁴ E.g., North Africa: D. J. Mattingly and R. B. Hitchner, "Technical Specifications for Some North African Olive Presses of Roman Date," in Amouretti and Brun, *Oil and Wine Production* (as above, note 7), 439–62, esp. figs. 1, 7; southern France: Brun, *Oléiculture* (as above, note 9), figs. 75, 80, 82, 83, 84, 87; Spain: M. Ponsich, *Implantation rurale antique sur le Bas-Guadalquivir* (Madrid-Paris, 1974), pls. LXVIII, LXXXIV.

²⁵ Semana weights are found in a variety of forms in the Aegean: e.g., Kalymnos (Arginunta): W. R. Paton and J. L. Myres, "On Some Karian and Hellenic Oil-Presses," *JHS* 18 (1898), fig. 8.2; Amorgos: ibid., fig. 8.3; Delos: P. Bruneau and P. Fraisse, "Pressoirs déliens," *BCH* 108 (1984), 713–30, esp. figs. 1, 2, 3, 10, 11, 12, 13, 14, 15. The earliest dated Semana weights are from the Hellenistic period and were found in the Crimea: M. Dufkova and J. Pečírka, "Excavations of Farms and Farmhouses in the Chora of Chersoneses in the Crimea," *Eirene* 8 (1970), 123–74, esp. figs. 10, 11; V. F. Gaidukevich, "Vinodelie na Bospore," in V. F. Gaidukevich and T. N. Knipevich, *Bosporskie goroda* (Moscow-Leningrad, 1958), 352–457, esp. figs. 43, 44, 67, 68, 73, 74, 75.

²⁶ There has been controversy as to whether the Semana weights were beam weights or screw weights. Paton and Myres ("Karian Oil-Presses," 216), the first to recognize these to be press weights, raise both possibilities. Drachman (*Oil Mills*, fig. 32), Gaidukevich ("Vinodelie," fig. 76), and recently Hadjisavvas ("Windlass Vs Screw: A Case-Study for the Reconstruction of an Olive Press," *RDAC* [1990], 181–85, pl. XXIX) have suggested that it was a screw weight. M. Christofle (*Essai de restitution d'un moulin à huile de l'époque romaine à Madaure (Constantin)* [Algiers, 1930]) was apparently the first to reconstruct it as a beam weight to which a drum was attached. Many pre-industrial presses in North Africa function in this manner (see, e.g., H. Camps Fabrer, *L'Olivier et l'huile dans l'Afrique romaine* [Algiers, 1953], fig. 11, quoting M. Gaudry, *La fabrication de l'huile en Aurès* [1949]), and there is little doubt that Christofle's reconstruction is correct (Mattingly and Hitchner, "Specifications," fig. 1; Bruneau and Fraisse, "Pressoirs déliens," fig. 4).

²⁷ See above, notes 9 and 10.

²⁸ See above, note 15.

²⁹ Hero of Alexandria gives instructions for the construction of four types of presses, the first being a lever, weight, and drum press, in which the drum is attached to the ground: *Mechanica* 3.13, 14; *Herons von Alexandria Mechanik und Katoptrik*, trans. L. Nix and W. Schmidt (Leipzig, 1900); Drachman, *Oil Mills*, 63–67, fig. 20; A. G. Drachman, *The Mechanical Technology of Greek and Roman Antiquity* (Copenhagen, 1963), 110–15.

the simple niche, slotted piers, and the slotted niche. The presses found in northern Syria are characterized by a grooved monolithic niche often secured by a large dovetail mortice.³⁰ In Cyprus, a somewhat similar but simpler monolithic slotted pier is found, without the dovetail base and the grooves characteristic of the Syrian type.³¹

In North Africa, several regional types of presses can be distinguished. It is of interest that the distribution areas of each type approximately coincide with the territories of the Roman provinces. In western Libya and part of Tunis—the Carthaginian region, later the Roman province of Africa—perforated piers are found (Fig. 5a).³² The region further to the west—Roman Numidia—is characterized by a dovetail mortice that apparently secured a wooden niche similar to those of stone found in northern Syria.³³ In the region of Roman Caesarean Mauritania, a T-shaped pier base was used,³⁴ and in Morocco—Roman Tinjanian Mauritania—a pier base with four depressions was used,³⁵ a type found also in Spain.³⁶

To the north of the Mediterranean, in the famous presses of Pompeii and the Campanian *villae rusticae* destroyed by the same eruptions of Vesuvius in 79 C.E., an unusual method of pressing was used in which a wooden standard was secured in a deep shaft that was approached via a short tunnel from a separate manhole.³⁷ The beam was probably inserted into a slot in the standard. The more common method was, however, a rectangular stone pier base with two rectangular depressions, a type found from Spain in the west to Yugoslavia in the east and present in large numbers in both southern France and Italy.³⁸ This device clearly supported two wooden slotted piers, is very similar to the pier base described by Cato, and is one of the characteristics of the Roman press.³⁹

The second important change in the development of the press after the introduction of the lever was the advent of the screw. There is archaeological evidence for the use of

³⁰ E.g., O. Callot, *Huileries antiques de Syrie du Nord* (Paris, 1984), pls. 67, 69, 70, 71, 72, 76.

³¹ Hadjisavvas, *Processing in Cyprus* (as above, note 11), 85–122. These monolithic piers are similar in form to the Phoenician slotted piers of the Zabadi press, but while the Phoenician piers appear in pairs and the beam is anchored between them, the Cypriot monoliths appear singly and the beam is inserted into the slot.

³² E.g., Mattingly and Hitchner, “Specifications,” figs. 1, 5, 9.

³³ E.g., Christofle, *Essai*, photos 11, 15, figs. 11, 12; Camps Fabrer, *L’Olivier*, pls. xi, xvi.

³⁴ P. Leveau, *Caesarea de Maurétanie: une ville romaine et ses campagnes* (Rome, 1984), figs. 117, 130, 156, 173 (broken), 232.

³⁵ E.g., A. Akerraz and M. Lenoir, “Les huileries de Volubilis,” *Bulletin d’archéologie marocaine* 14 (1981–82), 69–101, esp. pls. III, IV, X, XII, XIII, XVII.

³⁶ E. S. Ramos and A. de Luque Morano, “Memoria de las Excavaciones de Manguarra y San Jose (Cartama-Malaga),” *Noticiario Arqueológico Hispanico* 4 (1976), 491–546, esp. 492 (general plan of the excavation), pl. vi, 2.

³⁷ A. Sogliano, “Boscoreale: Villa romana in contrada detta Giuliana,” *Notizie degli Scavi*, pt. 2 (1897), 391–402, esp. figs. 1, 9.

³⁸ France: Brun, *Oléiculture*, figs. 69, 70, 71, 72, 73, 74, 77. Italy: e.g., J. J. Rossiter, *Roman Farm Buildings in Italy* (Oxford, 1978), 50–51, fig. 14 (items marked B). Yugoslavia: R. Matijasić, “Oil and Wine Production in Istria and Dalmatia in Classical Antiquity and the Early Middle Ages,” in Amouretti and Brun, *Oil and Wine Production* (as above, note 7), 249–59, esp. figs. 1, 3, 4, 6, 8, 11, 15. Spain: J. Guitart Duran, “Excavación en la zona sudeste de villa romana de Sentroma (Tiana),” *Pyrenae* 6 (1970), 111–65, esp. fig. 4d.

³⁹ Drachman (*Oil Mills*, 105–6) understands the pier base to be Cato’s *lapis pedicinus*. Brun (*Oléiculture*, 242, nn. 34, 35) understands the pier base to be Cato’s *forum* and the *pedicinus* to be the tenon at the bottom end of the *arbor*, the slotted pier.

the screw in presses in the southern Levant during the Roman period,⁴⁰ as is to be expected in light of references in classical⁴¹ and Talmudic literature.⁴² The vast majority of screw presses found, however, are from the Byzantine period and later.

Once more, the screw presses of each region are different. In the two main integrated technical cultures of the region, that of Judea in the south and Phoenicia in the north, the screw press adopted was that most easily adapted from the lever and weights press found in each region previously. The Judean grooved pier press consists of two piers on either side of a central vat. The piers have vertical grooves on their posterior and anterior faces and square mortices on their lateral faces (Fig. 6a).⁴³ This was the main screw oil press in the south in the Byzantine period. It was without doubt a single rotary screw press. Rods in the grooves in the front and at the back were to secure the press and withstand lateral pressure, while the mortices served to secure the thread board (Fig. 6b).⁴⁴ This press was clearly adapted from the Maresha press (Fig. 3a), the lever and weights press in the region that also had piers on either side of a central vat. It was only necessary to add mortices to the piers in order to secure the thread board of the screw press. The distribution area of this type of press is clearly defined in the south, while variants are found in other regions (Fig. 7). This is a striking example of a distribution pattern of central uniformity and peripheral variation. An interesting variant is the press from Tel Ṣafṣafot⁴⁵ in Lower Galilee (Fig. 6c). This press has dovetail mortices, instead of square ones, placed on the front and back faces instead of on the lateral faces of the piers. The mortices on the two piers are unusual in that they were of different lengths, and the bores were at different heights. The change to dovetail mortices was clearly due to regional preference, while the other changes were apparently to allow for the addition of an auxiliary drum to turn the screw with greater force (Fig. 6d). Another type of single rotary screw press also found in the south is the cross press, usually cut into the walls of caves.⁴⁶

The majority of the other screw oil presses in Lower Galilee, eastern Upper Galilee, and the Golan were also direct pressure presses. In the Golan, the main type is a screw

⁴⁰ Two screw press bases from Korazim have been dated to the Roman period: Z. Yeivin, "Two Ancient Oil Presses," *'Atiqot* (Hebrew series) 3 (1966), 52–62 (English abstract 6*–8*); idem, "Korazin," *Excavations and Surveys in Israel* 1 (1982), 64–67. See also idem, "Korazim—1983/1984," *Excavations and Surveys in Israel* 3 (1984), 66–71.

⁴¹ Pliny's historical summary (above, note 10) would place the introduction of the lever and screw press in the first century B.C.E. and that of the direct pressure screw press in the first century C.E. Vitruvius (*De Architectura* 6.6.3, trans. F. Granger [Cambridge, Mass.-London, 1962]) also mentions a screw press. There is some controversy about the date of Vitruvius, but the generally accepted view, that he wrote at the time of Augustus, would conform to this picture.

⁴² In relation to a press, the Hebrew term **טול** is usually understood as a "screw." It appears in the *Tosephta*, a work completed in the Roman period: *Tosephta Avoda Zara* 8(9), 3; *Tosephta Taharot* 11, 16; Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, 80, 89 nn. 173, 174.

⁴³ R. Frankel, "An Oil Press at Tel Ṣafṣafot," *Tel Aviv* 15–16 (1988–89), 77–91, esp. 82–83, fig. 3.

⁴⁴ Finding small depressions in the bedrock under the anterior and posterior grooves enabled B. Frankel to explain correctly the function of these grooves, as opposed to previous suggestions that they served as guides for the press board: e.g., Dalman, *Arbeit*, IV, pl. 69.

⁴⁵ Frankel, "Ṣafṣafot."

⁴⁶ Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, 70–71; G. Duncan, "New Rock Chambers and Galleries on Ophel," *PEFQ* (1926), 7–14; Dalman, *Arbeit*, IV, 231, pl. 74.

base consisting of a press bed with rounded corners and two open mortices.⁴⁷ This press has also been found in the basalt areas west of the Jordan River and is probably in this form because of the ease with which it could be cut in basalt slabs. Around the Sea of Galilee a variant of this press has central collection and radial grooves.⁴⁸ In Lower and eastern Upper Galilee, there are several examples of the Rama press (see Fig. 13j), in which the mortices are of the central dovetail type typical of the region (Fig. 8).⁴⁹ At the bottom, this mortice is rectangular. One half of it, however, has vertical sides, while the other half has sides that slope toward a narrow opening on the top. The second half of it, therefore, is dovetail in section, and the opening of the mortice as a whole is shaped like a capital “T.” Things to be secured in this device, in our case the screws or frame supports, have dovetail bases that are first inserted into the straight-sided half of the mortice and then slipped sideways into the half with sloping sides, the dovetail mortice. They are then secured by inserting wedges into the straight-sided half. This device is also used in other types of installations—e.g., the Bet Ha’emeq screw weight (Fig. 9, no. 5, and Fig. 12) and the Hanita winepress mortice (Fig. 13A and Fig. 14A)—and is the typical mortice of the northern regions. It is therefore clearly Phoenician. It is significant that a miniature version had been in use in Phoenician ivories of the Iron Age, and R. D. Barnett actually called it a Phoenician mortice.⁵⁰ It is also of interest that Hero of Alexandria describes this mortice in detail,⁵¹ another example of Hero’s knowledge of Phoenician devices.

The other main type of screw press is the lever and screw press described by both Pliny the Elder and Hero of Alexandria.⁵² A great variety of pre-industrial examples of this type of press survive.⁵³ The archaeological evidence for this press is the presence of screw weights. These have been found in Israel, mainly in Samaria and western and northern Upper Galilee, the regions where direct pressure screw presses were rare. In western Galilee the reason for the preference of the lever and screw press is clear. With

⁴⁷C. Ben David, “Olive Cultivation and Oil Production in Roman and Byzantine Golan” (M.A. thesis, Bar-Ilan University, 1989, in Hebrew).

⁴⁸A. M. Schneider, *The Church of the Multiplying of the Loaves and Fishes* (London, 1937), 28, no. 10; Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, fig. 77. Figure 78 (*ibid.*) shows an even rarer subtype with a round opening in the center of the press bed, which allowed the expressed liquid to flow into a separate vessel placed below the opening.

⁴⁹Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, fig. 79.

⁵⁰R. D. Barnett, *A Catalogue of the Nimrud Ivories in the British Museum* (London, 1957), 155, nos. C29, S362; R. D. Barnett, *Ancient Ivories in the Middle East*, Qedem 14 (Jerusalem, 1982), 13.

⁵¹*Mechanica* 3.6 (as above, note 29); Drachman, *Technology* (as above, note 29), 103–4.

⁵²Pliny, see above, note 10; Hero, *Mechanica* 3.15; Drachman, *Oil Mills*, 70–72; Drachman, *Technology*, 116–22.

⁵³Presses in which the screw turns in the weight and raises it: Dalman, *Arbeit*, IV, 216–220, pls. 57–61; Paton and Myres, “Karian Oil-Presses,” 211, fig. 1; Drachman, *Oil Mills*, 56, 122–24, figs. 40–41; Humbel, *Pressoirs*, fig. 16; M.-C. Amouretti et al., “A propos du pressoir à huile de l’archéologie industrielle à l’histoire,” *MéRome* 96 (1984), 379–421. Press in which the weight turns with the screw: Brun, *Oléiculture*, 113–16. Presses in which the screw raises a box of stones or stones on a board: Humbel, *Pressoirs*, pl. x, fig. 17. Presses in which the screw turns and is held in the lower press frame: Humbel, *Pressoirs*, pls. xx, xxi, figs. 15, 19, 22. Presses in which the screw turns and is held between two posts attached to the ground: Humbel, *Pressoirs*, pls. viii, ix, xv, fig. 18. Press in which the screw is fixed to the lower press frame and the nut above the beam is turned: Drachman, *Oil Mills*, 54, fig. 13.

the Zabadi press (Fig. 3b), with massive slotted piers at the fulcrum and lateral collection, it was easiest to retain the beam and replace the rope with a screw.⁵⁴

There are six main types of screw weights in the southern Levant, and they fall into two groups (Fig. 9).⁵⁵ In the three types that have central sockets and additional mortices (nos. 1–3), the screw turns in the socket, and the nut above the beam is fixed. The bottom of the screw is attached to the weight in such a way that it can turn but not work free. The first of these weights is the Samaria weight (Fig. 9, no. 1), with socket and exterior mortices, found in the southern Levant in large numbers, mainly in Samaria, but also commonly throughout the Mediterranean (Fig. 10).⁵⁶ The second is the Kasfa weight (Fig. 9, no. 2), with socket and interior mortices, of which to date only eight examples have been recorded, all in the region around Jerusalem (Fig. 11). Other types of Kasfa weight have been found, however, in large numbers in northern Syria, a rectangular example has been published from the Pontus in Anatolia, and similar weights have been found in Provence in southern France.⁵⁷ The third type is the Din‘ila weight (Fig. 9, no. 3), with socket and dovetail channel, found in Israel only in western and Upper Galilee and on Mount Hermon (Fig. 11). Its presence clearly continues farther north but is rare outside the southern Levant. A rectangular example has been published from the Pontus in Anatolia, and, surprisingly, pre-industrial examples have been found in Portugal.⁵⁸ The other three weights (Fig. 9, nos. 4–6) have a central mortice in which the screw was clearly fixed, instead of a socket, so that in presses using these weights the nut is turned and not the screw. Two of these types, the Mi‘ilia weight (Fig. 9, no. 4), with closed dovetail groove, and the Bet Ha‘emeq weight (Fig. 9, no. 5), with central dovetail mortice, are found only in western and Upper Galilee (Fig. 12). The Luvim weight (Fig. 9, no. 6), with square central mortice, is found on Mount Carmel and on the Plain of Sharon (Fig. 12). The Mi‘ilia, Bet Ha‘emeq, and Luvim weights are not found outside their respective regions at all.

Two unique screw weights were clearly introduced from afar. The very sophisticated Beit Loya weight⁵⁹ combines the characteristics of the Samaria and Kasfa weights (Fig. 9, nos. 1 and 2) with the addition of a bore and is almost identical to a weight published by O. Callot from northern Syria.⁶⁰ They differ only in that the Beit Loya weight is cylindri-

⁵⁴ Frankel, “Presses from Western Galilee” (as above, note 15).

⁵⁵ R. Frankel, “Screw Weights from Israel,” in Amouretti and Brun, *Oil and Wine Production* (as above, note 7), 107–18.

⁵⁶ Syria: Callot, *Huileries* (as above, note 30), pl. 41.1a, 1b (cylindrical); France: Brun, *Oléiculture*, figs. 81, 137, 152, 169 (rectangular), fig. 89 (cylindrical); Lesbos (Kalloni): Paton and Myres, “Karian Oil-Presses,” fig. 8.1 (rectangular); Greece: N. Ch. Kotzia, “Ανασκαφαὶ τῆς βασιλικῆς τοῦ Ααυρεωτικοῦ Ὁλύμπου,” *Πρακτ. Ἀρχ. Ἐτ.* (1952), 92–128, esp. figs. 1, 2, pl. 15 (rectangular); Anatolia (Pontus): J. G. C. Anderson, *A Journey of Exploration in Pontus* (Brussels, 1903), 15, fig. 1 (rectangular); Italy: P. Liverani, “Termini muti di centuriazione o contropesi di torchi?” *MélRome* 99 (1987), 111–27, figs. 1, 8, 9 (cylindrical).

⁵⁷ Syria: Callot, *Huileries*, pls. 40, 42, 43, 60, 63, 64, 104, 114, 122 (cylindrical); France: Brun, *Oléiculture*, figs. 76, 93, 102, 136, 138 (rectangular); Anatolia (Pontus): Anderson, *Journey*, 15, fig. 5 (rectangular).

⁵⁸ Anatolia (Pontus): Anderson, *Journey*, 15, fig. 4 (rectangular); Portugal: Humbel, *Pressoirs*, pl. 1; Amouretti, “A propos du pressoir,” figs. 5b, 6 (cylindrical).

⁵⁹ R. Frankel, J. Patrich, and Y. Tsafir, “The Oil Press at Horvath Beit Loya,” in *Christian Archaeology in the Holy Land: New Discoveries. Essays in Honour of V. C. Corbo*, ed. G. C. Bottini, L. Di Segni, and E. Alliata (Jerusalem, 1990), 287–300, esp. figs. 9, 11.

⁶⁰ Callot, *Huileries*, pl. 45.

cal and the Syrian weight octagonal, and in that the Beit Loya weight has a square mortice and the Syrian weight a dovetail one. The ‘Ain al-Jedide weight⁶¹ is rectangular, a characteristic that is very rare in Israel, and has pinholes otherwise unknown in Israel. Both these characteristics are found in screw weights from the Pontus.⁶² These two exceptional weights were found in monasteries and were almost certainly introduced to the area by monks from abroad.

Before attempting to explain the development of these screw weights, the single fixed screw winepress will be described. This press is almost always located in the center of the treading floor of a winery and consists of a screw mortice only. The screw is fixed in the mortice, and turning the nut exerts direct pressure on a board that presses on the grape skins piled up around the screw after treading (Fig. 1e). There are several ancient representations of this press: in mosaic pavements at Mount Nebo⁶³ and Umm al-Rassas⁶⁴ in Jordan and at Kabr Hiram near Tyre⁶⁵ in Lebanon (today exhibited in the Louvre). It evidently also appears in a twelfth-century manuscript⁶⁶ from Canterbury, probably copied from a Byzantine prototype. The single fixed screw press is almost certainly referred to in the Jerusalem Talmud,⁶⁷ but it is not mentioned in classical literature nor is there archaeological evidence for its presence except in the Levant.

The difference between the single fixed screw press and all the other types of presses is that a frail could not be placed below the press and the grape skins had to be enclosed in a wooden framework or a wound rope.⁶⁸ This probably explains why the pressing area is sometimes round and sometimes rectangular. In many cases the press is connected directly to the collecting vat by a channel or pipe. Two main types of mortice are used in the single fixed screw press. In the southern Ayalon press, the mortice is square (Figs. 13B, 14B), while in the northern Ḥanita press there is, once again, the central dovetail mortice, typical of the north (Figs. 13A, 14A). The Ayalon press does not penetrate into western or Upper Galilee. The Ḥanita press is found, however, in small numbers in the south.

We have seen that there were two primary technical cultures in which development can be traced stage by stage from the Iron Age until modern times, each with different

⁶¹ R. W. Hamilton, “Note on a Chapel and Winepress at ‘Ain el Jedīde,” *QDAP* 4 (1934–35), 111–17, esp. 113.

⁶² Anderson, *Journey*, 15.

⁶³ Church of St. George in S. J. Saller and B. Bagatti, *The Town of Nebo* (Jerusalem, 1949), pl. 24.1. Church of Sts. Lot and Prokopios in *ibid.*, pl. 18.1.

⁶⁴ M. Piccirillo, *The Mosaics of Jordan* (Amman, 1993), pl. 334.

⁶⁵ E. Renan, *Mission en Phénicie* (Paris, 1874), pl. 49.

⁶⁶ C. R. Dodwell and P. Clemoes, *The Old English Illustrated Hexateuch: British Museum Cotton Claudius B. IV* (Copenhagen, 1974), fol. 17r.

⁶⁷ Frankel, Avitsur, and Ayalon, *Technology of Olive Oil*, 80.

⁶⁸ On a terracotta in the British Museum there is a depiction of the pressing of grapes(?) enclosed in a wound rope: British Museum, Terracotta D550; J. Brøndsted, “La basilique de Cinq Martyrs à Kapluč,” in E. Dyggve and J. Brøndsted, *Recherches à Salone*, I (Copenhagen, 1928), 33–176, esp. fig. 102. Hero of Alexandria (*Mechanica* 3.13) refers to “the rope wound round the crushed grapes” (trans. Drachman, *Technology*, 111). Hero (*Mechanica* 3.16, 17) also gives instructions for making two types of wooden frames (*galeagra*) to enclose the material to be crushed. Drachman (*Oil Mills*, 60–62) identifies these with the *regulae* referred to by Pliny (*Naturalis Historia* 15.2.5–6) and by Columella (Lucius Junius Moderatus Columella, *Res Rustica*, trans. E. S. Forster and E. Heffner [Cambridge, Mass.–London, 1979], 12.52.10).

characteristics (Fig. 13). In the south, we find central collection, first appearing in the Iron Age and still present in pre-industrial installations;⁶⁹ plain piers; the direct pressure grooved pier press; and the square mortice—the mortice found in the Luvim screw weight, in the Ayalon winepress, in the grooved pier press, and in screw press bases. In the north, we find lateral collection; slotted piers; the lever and screw press; and the dovetail mortice—the closed dovetail mortice in the Bet Ha'emeq screw weight, in the Rama screw base, and in the Hanita winepress; and dovetail channels in the Din'ila and Mi'ilia screw weights. In the Şafşafot press and in other northern variants of the southern grooved pier press, the square mortices have been replaced by dovetail ones.

In intermediate and peripheral areas, regional characteristics can also be defined that are usually connected to the two main cultures in the north and the south. A press commonly found in Samaria has lateral collection, as in the north, but plain press piers on either side of the press bed, as in the south, together with a Samaria screw weight. In Lower Galilee and the Mount Carmel area there are several examples of the reverse—central vats with radial grooves but without plain piers. Two examples recently excavated, both of the Byzantine period, are lever and weights presses with very large beam weights with reversed T-bores. It is of interest that in the Jerusalem region an eclectic culture can be discerned with a remarkable variety of installations. This is without doubt a result of its being a “metropolis” connected to immediately surrounding regions as well as foreign lands.

I suggest a tentative model to explain the relationships between the various types of screw weights and single fixed screw winepresses (Fig. 14). The three screw weights without sockets (nos. 4–6) and the two types of fixed screw winepresses (A and B) are closely related. They all work on the same principle—a fixed screw and revolving nut, the simplest manner in which to use a screw. They all feature the same types of mortices—square in the south and dovetail in the north. Most important, these two devices, the single fixed screw winepress (A and B) and the lever and screw press in which the screw is fixed and the nut is turned (nos. 4–6), have, until now, been found only in the southern Levant. It is almost certain, therefore, that they developed in this region. The Din'ila screw weight (no. 3) with socket and dovetail channel is found almost only in the north, in Phoenicia, and probably developed from the other devices with dovetailed mortices found in the region (A and nos. 4 and 5). The Samaria weight (no. 1) probably originated in the western Mediterranean, and the Kasfa weight (no. 2) in Syria. The Kasfa weight, however, is technically an improvement on the Din'ila weight, the open channel of the Din'ila weight being closed in the Kasfa weight; this suggests that the Kasfa weight developed from the Din'ila weight in Syria, where the primary distribution areas of these two types probably met. The archaeological evidence does not at this stage provide a chronological framework for these developments, all the types being in use side by side in the Byzantine period. Hero of Alexandria,⁷⁰ however, who almost certainly wrote in the first century C.E., describes a screw weight that is extremely similar if not identical to the Din'ila weight. His testimony provides therefore a *terminus ante quem* in

⁶⁹ Al-Tafīl: Dalman, *Arbeit*, IV, fig. 56.

⁷⁰ *Mechanica* 3.15; Frankel, “Screw Weights” (as above, note 55), 110.

the first century C.E. for the appearance of the most developed form of the Phoenician weights, suggesting that the other Phoenician screw weights and winepresses (A and nos. 4 and 5) had developed earlier.⁷¹

There is a remarkable variety of presses found in the southern Levant in the Byzantine period. The variety of types of wineries was equally great. This remarkable diversity, as compared for example to the picture in North Africa or southern France, two regions that have also been researched in depth, demands explanation. Three factors may be suggested as the main causes for this phenomenon. The first is that the long history of oil and wine production in the region created a foundation of differentiated regional technical cultures. The second factor is that the Byzantine regions continued to flourish and develop technically long after the West had declined. This is illustrated also by the archaeological⁷² and literary evidence⁷³ for exports of wine and oil from the region during this period. The third reason for the remarkable technical diversity of presses for wine and oil in the southern Levant in the Byzantine era is that this region is the Holy Land, an area to which foreign techniques were introduced by religiously motivated pilgrims and settlers, apparently mainly monks.

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⁷¹A Kasfa screw weight from Sarepta (J. B. Pritchard, *Recovering Sarepta, a Phoenician City* [Princeton, 1978], 29–32, fig. 124) was dated to the Hellenistic/Roman period, which makes it the earliest dated screw weight known and would fit the model for the development of screw weights suggested here.

⁷²The two main types of Byzantine (late Roman) amphorae produced in the southern Levant are the “Gaza amphora”—D. P. S. Peacock and D. F. Williams, *Amphorae and the Roman Economy* (London-New York, 1986), Class 49; J. A. Riley, “Chapter 4: The Pottery from the Cisterns 1977.1, 1977.2 and 1977.3,” in *Excavations at Carthage, 1977, Conducted by the University of Michigan*, ed. J. H. Humphrey (Ann Arbor, 1981), 85–124, esp. 117, LR Amphora 4—and the “Palestinian bag-shaped amphora”—Peacock and Williams, *Amphorae*, Class 46; Riley, “Pottery from the Cisterns,” LR Amphora 5–6. They have been reported from stratified deposits. For those from Carthage: Riley, “Pottery from the Cisterns,” 116; from Rome: A. Carignani and F. Pacetti, “Le importazioni di anfore bizantine a Roma fra IV e V secolo: le evidenze di alcuni contesti urbani,” in *Recherches sur la céramique byzantine*, ed. V. Déroche and J.-M. Spieser, *BCH suppl.* 18 (Athens, 1989), 5–16, esp. 11; from many sites in southern France: M. Bonifay and F. Villedieu, “Importations d’amphores orientales en Gaule (Ve–VIIe siècle),” in Déroche and Spieser, *Recherches*, 17–46, esp. 18, 20, 21, 30, figs. 9, 10; from Argos: C. Abadie-Reynal, “Les amphores protobyzantines d’Argos,” in Déroche and Spieser, *Recherches*, 47–56, esp. 55, figs. 11, 12; from Athens: H. S. Robinson, *The Athenian Agora, V: Pottery of the Roman Period* (Princeton, 1959), vessels M329, M330; from Tomi on the Black Sea (today Constanta, Romania): M. Bucovăla and C. Pasca, “Descoperiri recente în necropolele de epoca romană și romano-bizantină la Tomis,” *Pontica* 21–22 (1988–89), 123–60, esp. 143, fig. 9 (a–b–c); from Benghazi: J. A. Riley, “The Coarse Pottery from Berenice,” in *Excavations at Sidi Kreibish, Benghazi (Berenice)*, II, ed. J. A. Lloyd (Tripoli, 1979), 91–297, esp. 219–22; and from Egypt: M. Egloff, *Kellia: La poterie copte* (Geneva, 1977), types 182, 183, 186.

⁷³P. Mayerson, “The Wine and Vineyards of Gaza in the Byzantine Period,” *BASOR* 257 (1985); idem, “The Gaza Wine Jar (Gazition) and the Lost Ashkelon Jar (Askalonium),” *IEJ* 42 (1992), 76–80; idem, “The Use of Ascalon Wine in the Medical Writers of the Fourth to Seventh Centuries,” *IEJ* 43 (1993), 169–73.